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(56) References: Reconditioning of agricultural equipment components: M.; Informagrotex, 1995, p.172. NOVIKOV N.A. Repair of components made from aluminium or aluminium alloys - Orel, OGSKhA, 1997, p.32-33. SU 1767044 A1, 07.10.1992. US 4082626, 04.04.1978.

(98) Address for correspondence:
410031, Saratov, ul. Valovaya, 5, k.8, for R.Ye. Agababyan.

(71) Applicant:
Agababyan Razmik Yenokovich

(72) Inventor: Agababyan R.Ye., Nechayev G.G.

(73) Owner of patent:
Agababyan Razmik Yenokovich

(54) METHOD FOR FORMING PROTECTIVE COATINGS ON VALVE COMPONENTS (ALTERNATIVE METHODS)

(57) The invention relates to formation of protective wear- and corrosion-resistant coatings on valve components, for example on ball and other valves, seating and packing components, and valve bodies. The method involves formation of a layer of aluminium or anodized aluminium alloy, and microarc oxidation; after the layer has been formed, it is mechanically worked until surface geometry is restored. The layer is formed with a through porosity of no more than 8% and with pore size no greater than 1 μm, and the microarc oxidation is carried out in a weakly alkaline electrolyte containing 3 g/l KOH and 10 g/l water glass at density of current 10-15 A/dm² and temperature of electrolyte 40-60°C until a layer of aluminium oxide 100-250 μm thick is obtained. Also, if components are made from aluminium or anodized aluminium alloy, an aluminium underlayer is not applied; instead, the surface of the item itself serves as the underlayer. Technical result: a durable wear- and corrosion-resistant coating is obtained on

components made from any structural material or alloy; adhesion, microhardness, and resistance to cyclic temperature stresses are improved; and the coating is not inclined to crack or crumble. 2 's.p. f-ly'.

The invention relates to formation of protective wear- and corrosion-resistant coatings on components. The main, but not sole, use for such coatings is for valve components, for example for ball and other valves, for seating and packing components, and for valve bodies.

A method is known for obtaining a protective coating on an underlying material (patent RU 2142520 MPK, C 23 C 28/00; 22.07.1994), involving applying the coating by depositing a metallic matrix M1 from a bath containing particles of CrAlM2 in order to coprecipitate particles with the matrix; in this method, M1 is, at least, one element selected from a group consisting of Ni, Co, or Fe, and M2 is, at least, one element selected from a group consisting of V, Si, Ti, Hf, Ta, Nb, Mn, Pt, or the rare-earth elements. The method is distinctive in that aluminization, chromization, or siliconization of underlayer is carried out before precipitation, and precipitation can be electrolytic or non-electrolytic. In addition, heat treatment is carried out on the aluminized, siliconized or chromized underlayer in a vacuum before and after the M1 CrAlM2 coprecipitation; if heat treatment is carried out before coprecipitation, it is done at a temperature of about 1100°C for approximately 1 hour, while if heat treatment is carried out after coprecipitation, it is done at a temperature of about 1100°C for 1 hour.

A disadvantage of this method is low wear and corrosion resistance of the coating applied.

A method is known of creating protective coatings in equipment of the ball-valve type by creating a layer of ceramic coating on a ball valve made of an alloy on an aluminium base with a thickness of, for example, 0.1 - 0.5 mm (patent RU 2104434 MPK; F 16 K 5/06 dated 21.03.1996). Creation of a ceramic coating involves the use of ceramics technology: preparation of a mixture, shaping and firing (Dictionary and Reference Book of Powder Metallurgy, Kiev, Naukova Dumka, 1982, p.84).

Firing of ceramics takes place at temperatures above 800°C, while the melting point of aluminium alloys is 660°C. This makes the process of forming a ceramic coating extremely complicated and difficult to implement due to melting of the material from which the base of the ball valve is made (aluminium alloy).

A method is also known of protecting the surface of metal bars using a coating consisting of a layer of aluminium (patent RU 2145981 MPK; C 23 C 4/08). The coating is formed in one pass by a metal spray gun and has a thickness of 0.1 - 0.3 mm and through porosity of no more than 6-8%; aluminium content in the material of the coating is no less than 90-93%, while strength of adhesion is at least 30-50 MPa. The coating can be applied to an unmachined degreased surface. The density of the coating material is as

great as the density of cast aluminium (2.35 - 2.41 g/cm³. In order to apply the coating, a wire is used with an aluminium content of over 99%, 2.0 - 2.3 mm in diameter).

A disadvantage of the above method is low wear resistance of the aluminium coating.

A closer analogue to the proposed method is a method described in the training manual "Repair of components made from aluminium or aluminium alloys", Novikov N.A., Orel, OGSKhA, 1997, p.32-33. In this method, the surface that is to be repaired is worked mechanically and is then subjected to microarc oxidation. As a result, a ceramic coating is formed. The electrolyte used when forming the ceramic coating contains insoluble powdered materials in suspension. However, this method, for reasons connected with the use of powders under mass-production conditions, does not provide consistent results; this is due to rapid change in the electrolyte composition due both to depletion of the insoluble components and to deposition of the components of the suspension in the precipitate. In addition, coatings of this type are inclined to crack, flake off or crumble due to the absence of chemical links (chemical affinity) between the oxide applied and the material from which the component is made. The adhesion of such coatings is not great.

The task of the invention is to develop a method which makes it possible to form corrosion- and wear-resistant protective coatings on valve components made from various materials: construction metals and alloys, graphite, and heat-resistant plastic.

The essence of the invention lies in the fact that in the method for forming protective coatings on components of valves used for gases or liquids, involving formation of a layer of aluminium or anodized aluminium alloy and microarc oxidation, after the layer is formed it is mechanically worked until surface geometry is restored, the layer is formed with through porosity of no more than 8% and with pore size no more than 1 μm, and the microarc oxidation is carried out in a weakly alkaline electrolyte containing 3 g/l KOH and 10 g/l water glass at density of current 10-15 A/dm² and temperature of electrolyte 40-60°C until a layer of aluminium oxide 100-250 μm thick is obtained.

In addition, the essence of the second version of the method lies in the fact that in the method for forming protective coatings on components of valves for gases or liquids, involving microarc oxidation, the components are made from aluminium or anodized aluminium alloy with porosity no more than 8% and pore size no more than 1 μm, and the microarc oxidation is carried out in a weakly alkaline electrolyte containing 3 g/l KOH and 10 g/l water glass at density of current 10-15 A/dm² and temperature of electrolyte 40-60°C until a layer of aluminium oxide 100-250 μm thick is obtained.

The technical result of the proposed method is that a strong wear- and corrosion-resistant coating is obtained on components made from practically any structural metal or alloy, for example steel, iron, bronze, brass, Silumin etc., or even from graphite or heat-

resistant plastic. The coatings obtained have high adhesion (up to 2500 kg/cm^2), microhardness up to 2900 kg/mm^2, and resistance to cyclic temperature stresses. The coatings are not inclined to crack or crumble.

The method proposed for forming protective coatings on components, mainly for valves for gases or liquids, involves the following.

For the method's first variant, where a layer of aluminium is applied, the technical result obtained is explained by the fact that the two-layer structure obtained possesses chemical affinity and, in addition, the softer and more plastic aluminium layer plays the role of a distinctly shock-absorbing element, conforming to and adjusting itself to any stresses that may arise and that may lead to the cracking or destruction of the oxide layer of the coating.

For the method's second variant, the high adhesion of the protective oxide coating results from the chemical affinity of aluminium and aluminium oxide, while the high resistance to wear results from the "honeycomb" crystalline structure of the aluminium oxide layer obtained in the 'MDO' process.

In addition, it is that same honeycomb structure of the oxide that makes it possible to "co-ordinate" the coefficient of thermal expansion of the metal and the oxide.

After a workpiece has been prepared, its surface is degreased and then a layer of aluminium is applied using any of the known methods: spray-coating, immersion in molten aluminium, spattering at the phase where it is sufficiently liquid to form drops, etc. Thickness of aluminium coating is monitored by any of the existing methods: ultrasound, eddy-current etc., thickness measuring instruments or sensors etc.

The temperature regime under which the aluminium layer is applied is determined by the coating method chosen. A coating of uniform thickness is formed over the entire surface of the component, without allowing any areas to remain uncovered. Through porosity of no more than 8%, with pore size no more than 1 μm, is permitted. The aluminium coating is applied up to a thickness of layer of 0.4 - 0.5 mm. In order to restore the shape and dimensions of the component it is mechanically worked, and this improves the surface and the quality of the coating: pressure-moulding, machining, or grinding are used, or all these operations together if necessary, until the required roughness is achieved, < 2.5 μm as a rule.

The thickness of the coating is monitored during the entire process of forming the aluminium layer; the coating thickness is not allowed to fall below 0.3 mm before the completion stage.

Then, by oxidizing the aluminium, an outer layer of aluminium oxide is formed; the aluminium oxide has a high resistance to corrosion and wear. In order to do this, the item, with layer of aluminium 0.3 mm thick applied, is first of all cleaned and degreased.

The item is fixed to an electrical conductor and placed in an electrolyte bath, preferably a weakly alkaline bath containing, for example, 2 g/l KOH or NaOH or 3 g/l KOH and 10 g/l water glass.

A voltage is applied and microarc oxidation is carried out at a density of current of 10-15 A/dm^2 and at a temperature of electrolyte of 40-60°C until an oxide layer 100-150 μm thick is obtained.

The techniques used at this stage of forming the coating on the item provide uniform thickness, strength, roughness, and wear-resistance over the entire surface.

With the aim of obtaining the required cleanliness of surface after microarc oxidation, the working friction surfaces are finally ground or polished. As a result, a two-layer coating is obtained on the item: the inner layer, with a thickness of 0.1 - 0.2 mm, is aluminium, and the outer layer, 0.07 - 0.13 mm thick, is aluminium oxide.

The mechanism for obtaining the two-layer coating on the working surfaces using the method described is distinct from the analogues in that, in the process for forming the layers of the coating on the item, the internal crystalline structure of the item does not undergo any changes; this is not the case with the technique used for obtaining ball valves with ceramic coatings. With regard to the closer analogue, the distinctiveness lies in the fact that operations are added which convert the protective layer of aluminium, which is subject to corrosion and which has a low resistance to wear, into an anti-corrosion and wear-resistant layer and structure.

Example.

Method for obtaining a protective coating on a DU-50 ball valve. Operations and regimes are implemented using the procedures given above. In addition, at places where there are sudden changes in the shapes of surfaces, continuity is monitored, and if necessary a repeat application of aluminium is made along the line of a sudden change. The surface of the aluminium coating obtained is then worked in order to obtain the geometry and dimensions required. After being degreased, the valve is then placed in an electrolyte bath and microarc oxidation of the aluminium layer takes place, obtaining a layer of aluminium oxide 100 μm thick. To achieve this, the microarc oxidation is carried out at a current density of 10-15 A/dm^2 for one hour. The electrolyte used for the microarc oxidation is weakly alkaline and contains 3 g/l KOH and 10 g/l water glass solution (silicate office glue). Electrolyte temperature during the process was kept within the range 40-60°C. The electrolyte bath was cooled by pumping water through the water-cooling sleeve of the electrolyte cell. During the process, the electrolyte was agitated by air bubbles.

When analysed under the microscope, the structure of the outer layer obtained is characterised by a "honeycomb" structure, and this provides additional strength for the coating.

Claims for the invention:

1. Method for forming protective coatings on components for valves for gases or liquids, involving formation of a layer of aluminium or anodised aluminium alloy and microarc oxidation, distinctive in that after the layer is formed it is mechanically worked until the geometry of the surface is restored, the layer is formed with through porosity of no more than 8% and with pore size no more than 1 μm, and the microarc oxidation is carried out in a weakly alkaline electrolyte containing 3 g/l KOH and 10 g/l water glass at a density of current of 10-15 A/dm² and temperature of electrolyte 40-60°C until a layer of aluminium oxide100-250 μm thick is obtained.

2. Method for forming protective coatings on components for valves for gases or liquids, involving microarc oxidation, distinctive in that the components are made from aluminium or anodised aluminium alloy with porosity no more than 8% and pore size no more than 1 μm, and the microarc oxidation is carried out in a weakly alkaline electrolyte containing 3 g/l KOH and 10 g/l water glass at a density of current of 10-15 A/dm² and temperature of electrolyte 40-60°C until a layer of aluminium oxide 100-250 μm thick is obtained.